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Indian Standard

SPECIFICATION FOR PRESSURE SENSITIVE ADHESIVE TAPES FOR ELECTRICAL PURPOSE

PART II METHODS OF TEST

(Third Reprint DECEMBER 1997)

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BUREAU OF INDIAN STANDARDS
MANAK BHAVAN, 9 BAHADUR SHAH ZAFAR MARG
NEW DELHI 110002

Gr 7 *January* 1978

Indian Standard

SPECIFICATION FOR PRESSURE SENSITIVE ADHESIVE TAPES FOR ELECTRICAL PURPOSES

PART II METHODS OF TEST

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AMENDMENT NO. 1 APRIL 2001
TO
IS 7809 (PART 2) : 1977 SPECIFICATION FOR PRESSURE SENSITIVE ADHESIVE TAPES FOR ELECTRICAL PURPOSES

PART 2 METHODS OF TEST

[*Page* 8, *clause* 6.5(a)]—Substitute the following for the existing matter.

"**a)** The product is described as 'Flame-Retardant' under the terms of this standard if at least four of the five specimens retard flame and fire gets extinguished before the 50 mm mark is reached."

[*Page* 8, *clause* 6.5(b)] — Delete and renumber subsequent items accordingly.

(ET 02)

Reprography Unit, BIS, New Delhi, India

1. SCOPE

1.1 This standard (Part II) covers the methods of test for checking the requirements of pressure sensitive adhesive tapes for electrical purposes.

2. GENERAL NOTES ON TESTS

2.1 The first three layers of tape from the roll to be tested shall be discarded before removing test specimens.

2.2 Sample roll shall be subjected for at least 24 hours to a standard atmosphere at a temperature of 27 ± 2°C and relative humidity 65 ± 2 percent before test specimens are removed for test. Unless otherwise specified, all individual test specimens shall be conditioned for one hour and testing shall be conducted in the same standard atmosphere.

2.2.1 If testing is not conducted in the standard atmosphere, the test may be carried out in an atmosphere of relative humidity of 65 ± 5 percent, the test being started within three minutes of removal of each test specimen from the standard atmosphere.

3. THICKNESS

3.1 Test Apparatus — A dead-weight dial-type micrometer having two ground and lapped concentric circular surfaces, flat within 0·001 mm and parallel to within 0·003 mm shall be used. The upper surface shall be 6 to 8 mm in diameter and the lower surface larger than the upper one. The upper surface shall move on the axis perpendicular to the two faces.

The dial shall be graduated to read correctly to 0·002 mm. The frame of the micrometer shall be of such rigidity that a load of 15 N applied to the dial housing, out of contact with either the weight or the pressure foot spindle, will produce a deflection of the frame not greater than 0·002 mm (as indicated on the micrometer dial). The pressure exerted on the specimen shall be 100 ± 10 kN/m^2.

The accuracy of the micrometer shall be checked frequently by means of a set of steel gauges; the measuring errors of the micrometer shall not exceed 0·005 mm.

3.2 Test Specimens — Nine specimens, at least 75 mm long, are cut from the roll at intervals of not less than 300 mm.

3.3 Procedure — Place the test piece between the jaws of the micrometer with adhesive side down in contact with the fixed foot. Take care to ensure that no air bubbles are trapped. Lower the moving pressure foot gently onto the surface of the tape and take the reading on the dial within 2 seconds. Make the measurement to the nearest 0·005 mm.

3.4 Results — Report the central value as well as the maximum and minimum values of the nine measurements of thickness in millimetres.

4. DETERMINATION OF ELECTROLYTIC CORROSION

4.1 When electrolytic corrosion is of significance, the determination is carried out according to IS : 8516-1977*. The insulation resistance test method shall be used as a screening test. If the material passes, then a choice may be made between the visual test method and the wire tensile test method.

5. RESISTANCE TO PENETRATION AT ELEVATED TEMPERATURE

5.1 Apparatus — Any apparatus may be used which detects penetration when a 1·5 mm diameter sphere is pressed under prescribed conditions into the surface of the tape placed on a corrosion-resistant steel plate 100 mm long, 30 mm wide and 3 mm thick.

An oven capable of raising the temperature of the apparatus chosen at a rate of 30 ± 5°C per hour.

The apparatus described in Fig. 1 is an example of an apparatus that gives good results.

A magnetized steel rod, recessed at one end, holds the 1·5 mm diameter steel ball. This rod is fixed in a C-clamp which further contains a counterbalance and is mounted in such a way that the necessary freedom of rotation exists.

The counterbalance consists of an adjustable rider capable of neutralizing the pressure of the steel ball against the steel plate when there is no load on the lower leg of the C-clamp. In use, the lower leg of this C-clamp is equipped to exert a force of 10 N vertically downwards against the corrosion-resistant steel plate lying in a horizontal plane.

The apparatus is equipped with a device to indicate electrical contact between the steel ball and the steel plate. A 110 V source of electricity is to be used. The temperature of the steel plate shall be measured at a point as near as possible to the point where the pressure is exerted. The use of a thermocouple is suggested.

5.2 Test specimens — Take five strips of tape, each 25 mm long, from the roll at intervals of not less than 300 mm.

5.3 Procedure — With no load on the penetration sphere, each specimen shall be placed under the sphere at room temperature, and the sphere then cautiously loaded, so that a compressive load of 10 N is exerted on the specimen. The temperature of the apparatus shall then be raised at a uniform rate of 30 ± 5°C per hour until penetration occurs.

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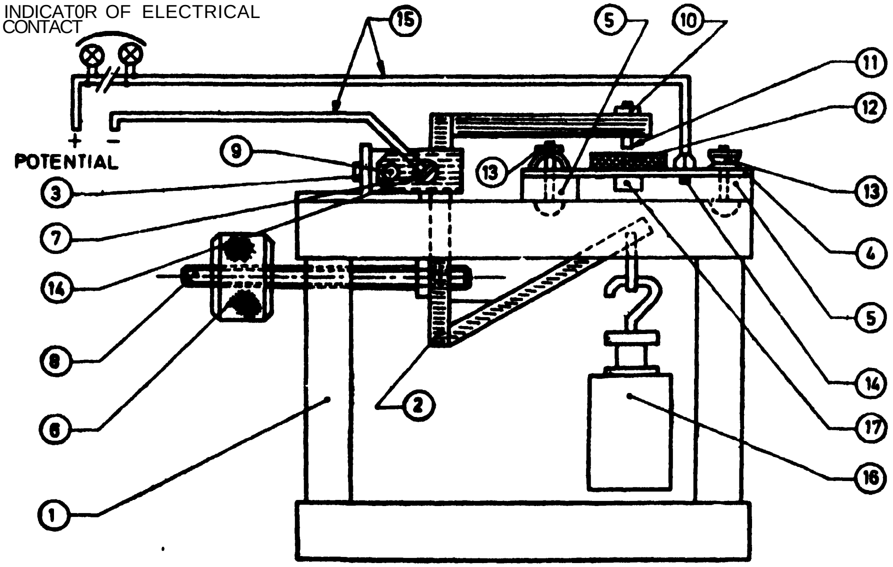
*Methods of test for determining electrolytic corrosion with insulating materials.

5.4 Results — Report the central value as well as the maximum and minimum values of the five measured temperatures at penetration in degrees Celsius.



1. Frame—steel
2. Pivot arm—steel
3. Screw holding pivot block to frame—steel.
4. Plate—stainless steel (easy removable)
5. Insulating blocks—phenolic laminate No electrical contact between plate and frame
6. Knob to balance pivot arm with weight removed—steel
7. Pivot block—steel
8. Pivot pin to adjust knob 6—steel
9. Stud + nut—thread size to match adjusting knob (6)
10. Nut and mounting rod—steel
11. 1·5 mm stainless steel ball affixed to mounting rod
12. Tape or film specimen to be tested
13. Studs to facilitate removal of stainless steel plate
14. Screws for making electrical connections
15. Electrical leads to outside of oven
16. 1 000 g weight
17. Hole for the thermocouple

FIG. 1 TYPICAL PENETRATION TESTER

6. RESISTANCE TO FLAME PROPAGATION

6.1 Principle — The following measurements are made on specimens of definite size and under defined conditions:

a) The time elapsing between the instant when it catches fire and the instant when it extinguishes itself, and

b) The length of tape burnt during the test.

6.2 Apparatus — It shall be as described below:

a) A protective device, comprising essentially a rectangular metal box 250 mm X 250 mm X 750 mm (*see* Fig. 2), in which a test specimen may be suspended;

b) A stop-watch with an accuracy of ± 0·2 s;

c) A Bunsen burner with a tube of about 4 mm internal diameter and giving a non-oxidizing flame 20 to 25 mm high; and

d) A primer in the form of an isosceles triangle with base 25 mm and 30 mm high, cut from untreated and uncoated regenerated cellulose film with a mass per unit area of 50 g/m^2 to 60 g/m^2

6.3 Teat Specimens — The test shall be made within 3 minutes after the removal of the specimen from the roll.

Five test specimens 300 mm in length, are removed from the roll by pulling radially, at a rate of approximately 300 mm/s, at intervals of 300 mm.

If the width of the tape is. 25 mm or less, the width of the specimen is the width of the tape.

If the width of the tape is greater than 25 mm, the specimen shall be cut out of the middle of the tape to a width of 25 mm. The specimens shall be cut with a sharp tool to avoid tearing at the edges.

Using ink or any other suitable medium, a line perpendicular to the longer sides is drawn 50 mm from one end of the test specimen.

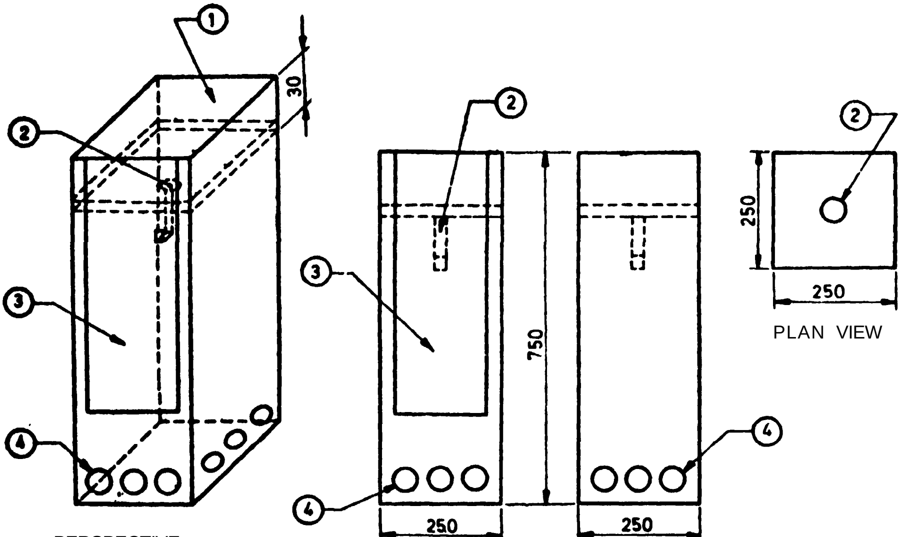
NOTE — With tapes narrower than 25 mm, apparently different levels of flammability will be obtained.

6.4 Procedure — The base of the primer is fixed to the adhesive side of the tape at the end of the test specimen from which the 50 mm mark is measured, with a maximum overlap of 5 mm.

A clip is placed at the other end of the test specimen and the whole is then suspended inside the metal box so that the tape hangs freely and vertically. The sliding window is then slightly raised and the gas flame is brought up to the apex of the primer.

As soon as the primer is ignited, the Bunsen burner is removed, the sliding window rapidly lowered and the stop-watch started.

When the flame goes out, the stop-watch is stopped.



PERSPECTIVE FRONT ELEVATION SIDE AND REAR ELEVATION PLAN VIEW

1. Open side
2. Movable clip placed at the centre 30 mm below the upper edges
3. Sliding window
4. 12 mm holes uniformly distributed around the four sides along a horizontal line at a height of 25 mm from the base

FIG. 2 DRAUGHT PROTECTION DEVICE

6.5 Results — Following criterion shall apply:

a) The product is described as 'non-ignitable' under the terms of this standard if at least four of the five specimens do not burn at all.

b) The product is described as 'self-extinguishing' if at least four of the five burning test specimens extinguish themselves before the 50 mm mark is reached. The central value as well as the maximum and minimum values of the five burning times, in seconds, are reported together with the maximum length burnt in millimetres in any of the five tests.

c) The product is described as 'flammable' if at least four of the five test specimens burn, melt or carbonize beyond the 50 mm mark. The central value as well as the maximum and minimum values of the five burning times, in seconds, are reported.

d) In case the product may not be described under (a), (b) or (c), the individual results for each specimen arc to be stated in the test report.

7. THERMAL ENDURANCE

7.0 The specification for an individual tape given in Part III of this standard shall specify which of the following methods is to be used together with the end-of-life criterion and state that, when required by the purchaser, the manufacturer shall certify that the pressure-sensitive tape has been made using materials and processes that have been shown to give a product which will meet the requirements specified.

7.1 Voltage Breakdown

7.1.1 *Specimens* — The width of tape to be used shall be in the range of 12 mm to 25 mm. Preferably a width of 25 mm shall be used.

The specimens of tapes to be tested are prepared by wrapping the tapes spirally around clean brass (or copper) rods of 8 mm diameter over a length of 200 mm with overlap slightly less than 50 percent. The rod. should be sufficiently long so that one end may be left unwrapped and used for making an electrical connection.

Tapes should be stretched during wrapping as follows:

a) Tapes having an elongation at break of more than 100 percent: approximately 30 to 50 percent.

b) Tapes having an elongation at break of 40 to 100 percent: 20 to 30 percent.

c) Tapes having an elongation at break of less than 40 percent: very low tension.

Immediately after wrapping, thermosetting tapes shall be cured in accordance with the manufacturers instructions.

The number of test specimens shall be not less than five for each ageing period at each ageing temperature.

7.1.2 ***Procedure*** — The oven to be used shall be in accordance with 9 of 8504 (Part I)-1977*.

Put the test specimens, the wrapped rods, vertically into the oven, the unwrapped end of the rods pointing downward.

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*Guide for determination of thermal endurance properties of electrical insulating materials : Part I Temperature indices and thermal endurance profiles.

Instructions regarding exposure temperatures and time periods are given in 8 of IS : 8504 (Part I)-1977*, and ageing temperatures for various types of pressure sensitive adhesive tapes are given in Part III of this standard. Since voltage breakdown is a destructive test method, the total number of test specimens will depend on the number of ageing periods necessary to exceed the end-of-life criterion.

At the end of each ageing period, specimens to be tested are removed from the oven and kept at room temperature for approximately 2 hours.

As specified in Part III of this standard, a conductive paint or a metal foil at the centre portion of the test specimen will serve as one electrode having a length of 100 mm; the second connection will be applied to the unwrapped part of the rod.

In accordance with **6.3** and **7.1** of IS: 2584-1963†, an alternating current of 40 to 62 Hz is applied. The voltage shall be raised at a nearly uniform rate until breakdown occurs between 10 to 20 seconds.

7.1.3 *Evaluation* — Selectt he central value of 5 measured values for each ageing temperature and each ageing period.

Prepare a graph in accordance with the instructions given in **11.2** of IS : 8504 (Part I)-1977* and determine, as in Fig. 2 of IS : 8504 (Part I)-1977*, the ageing time for each exposure temperature. The crossing points for the three different exposure temperatures are read as the time to failure.

Establish the thermal endurance graph in accordance with the instructions in **11.3** and Fig. 3A of IS: 8504 (Part I)-1977*, by a graphical treatment of the results. Deduce the temperature index from the graph at 20000 hours [*see* **11.4** (TI) of IS : 8504 (Part I)-1977*.]

7.2 Loss of Mass

7.2.1 *Specimens* — Take 15 tape specimens having a preferred length of 100 mm and a preferred width of 25 mm. To establish the initial mass the specimens shall be maintained for 48 hours at the lowest ageing temperature [in accordance with **5.2** (a) of IS: 8504 (Part I)-1977*]. After this treatment they shall be kept for 2 hours in an atmosphere of 27 ± 2°C and 65 ± 5 percent relative humidity; the mass is then determined with an accuracy of 0·1 mg. Precautions are taken to ignore the mass of the supporting means.

7.2.2 *Procedure* — For each of the three temperatures, five specimens are placed in a vertical position in each oven kept at one of the three temperatures given in the relevant section of Part III of this standard.

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*Guide for determination of thermal endurance properties of electrical insulating materials: Part I Temperature indices and thermal endurance profiles.

†Method of test for electric strength of solid insulating materials at power frequencies.

The oven shall be as described in **7.1.2.**

The specimens are suspended freely on a light metal frame, inside or outside a test tube.

Since loss of mass is a non-destructive test, ageing periods may be adjusted according to **8.5** of IS : 8504 (Part I)-1977*. It might be useful to check the change in mass after a period of 7, 14, 28, 56 days, or more, when ageing is performed at the lowest ageing temperature. The ageing periods at different temperatures are to be chosen accordingly.

After each ageing period, remove the test specimens from the oven and from the test tube, if used, and maintain them for 2 hours in an atmosphere of 27 ± 2°C and 65 ± 5 percent RH; the. mass is then determined with an accuracy of 0·1 mg. Continue ageing of the specimens until the end point as specified in the relevant section of Part III of this standard is reached.

7.2.3 ***Evaluation*** — Convert the individual results obtained into the respective percentage loss of mass as follows:

$$\text{Loss of mass} = \frac{(\text{initial mass} - \text{mass after ageing})}{\text{initial mass}} \times 100$$

Select the central value of 5 measured values for each ageing. temperature and each ageing period.

Prepare a graph in accordance with the instructions in **11·2** of IS : 8504 (Part I)-1977* and determine, as in Fig. 2 of IS : 8504 (Part I)-1977*, the ageing time for each exposure temperature. The crossing points for the three different temperatures are read as the times to failure.

Establish the thermal endurance graph according to the instructions in **11.3** and Fig. 3A of IS : 8504 (Part I)-1977*, by a graphical treatment of the results. Deduce the temperature index from the graph at 20 000 hours [*see* **11.4** of IS : 8504 (Part I)-1977*].

8. CURIN PROPERTIES OF THERMOSETTING ADHESIVE TAPES

8.1 Bond Separation During Thermal Treatment (Adhesive to Backing)

8.1.1 *Apparatus* — It shall consist of the following:

a) A roller of either of the following two tapes:
    1) A polished steel roller having a diameter of at least 50 mm being able to exert a pressure of 20 N per 10 mm width, or

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*Guide for determination of thermal endurance properties of electrical insulating materials: Part I Temperature indices and thermal endurance profiles.

2) A rubber-covered steel roller, being a steel roller, 80 mm in diameter and 44 mm in width, covered with rubber approximately 6 mm thick, having an IRH of 80 ± 5.

The mass of the roller shall be 2 kg.

The roller shall be so constructed that no additional load is added when performing the rolling action.

b) A clean, flat, metal or glass plate approximately 600 × 200 mm.

c) Weights having a mass of 50 g with clamps.

8.1.2 ***Test Specimens*** — Six strips 150 mm in length, are removed from the roll by pulling radially at a rate of approximately 300 mm/s, at intervals of 300 mm. The width of the strip to prepare a test specimen shall be 12 mm.

If the width of the tape is greater than 12 mm, the specimen shall be cut out of the middle of the tape to a width of 12 mm. The specimen shall be cut with a sharp tool to avoid tearing at the edges.

Three test specimens are formed by lightly pressing the adhesive side of one strip to the back of another strip in such a way that an overlap of 12 × 12 mm with a tolerance of ± 0·8 mm is formed. Pass, without the application of additional pressure, the roller twice back and forward over the joint at a speed of approximately 10 mm/s.

8.1.3 ***Procedure*** — A weight of 50 g is attached to each of the test specimens which are then suspended freely in an oven at the temperature laid down in the specification for individual material. The test is considered satisfactory if at the end of 20 minutes there has been no complete bond separation.

8.1.4 ***Results*** — Report the number of passes or failures.

8.2 Bond Separation After Thermal Treatment (Adhesive to Backing)

8.2.1 ***Apparatus*** — It shall consist of following:

a) A roller in accordance with **8.1.1** (a);

b) A clean, flat, metal or glass plate approximately 600 × 200 mm; and

c) Weights having a mass of 500 g provided with clamps.

8.2.2 ***Test Specimens*** — Three test specimens,· prepared as described in **8.1.2.**

8.2.3 ***Procedure*** — The three specimens are suspended freely in an **oven** which is at the temperature laid down in the relevant specification for individual material. After the time laid down in the specification has elapsed, a weight of 500 g is attached to each specimen in the oven. The weights shall be attached within 15 seconds. (The time and temperature are normally those recommended by the manufacturer for curing the tape.)

Before being attached, the weights shall have been stored in the oven at the prescribed temperature for a time sufficient to ensure temperature equilibrium of the weights and the oven.

Immediately after the attachment of the weights, the oven is closed and the 20-minute period starts.

At the end of this 20-minute period, it is noted whether or not the weight is still suspended by the specimen.

8.2.4 ***Results*** — Report the number of passes or failures.

8.3 Flagging or End-Lifting

8.3.0 *General*

8.3.0.1 Flagging or end-lifting means the lifting of an exposed and of a wrapping of tape after application of the method described and subsequent test conditioning, thus forming a flag or tab tangential to the contour of the wrap or a partial or complete unwinding.

8.3.0.2 Knowledge of the flagging or end-lifting is useful in determining whether the adhesion of the tape to a backing of the same tape is adequate for applications where unwinding may occur. The flagging may occur under normal conditions, during the curing cycle of thermosetting adhesives or during immersion in liquid.

8.3.1 ***Apparatus*** — It shall consist of following:

a) A simple winding jig designed to hold a rod at each end with a means for rotating the rod so that the specimen may be wound thereon. The winding jig should be attached to a rigid support with the rod held in a horizontal position.

b) Rods of any suitable metal or glass of 6 mm nominal diameter (or other diameter as required by the specification sheet for a particular tape).

c) Attachable masses of 100, 200, 300 and 400 g, and

d) A suitable method of measuring 2 mm to the nearest 0·5 mm.

8.3.2 ***Specimens*** — Three strips of tape at least 100 mm long are removed from the roll by pulling radially, at a rate of approximately 300 mm/s, at intervals of 300 mm.

If the width of the tape is greater than 12 mm, the specimen shall be cut out of the middle of the tape to a width of 9 mm. The specimen shall be cut with a sharp tool to avoid tearing the edges.

NOTE — It is important to protect the adhesive surface from dust and to avoid touching it with the fingers or any other foreign object.

8.3.3 *Preparation of Specimens for Test* — A rod of 6 mm diameter (unless otherwise specified) is mounted in a horizontal position in the jig. A mass in the ratio of 400 g to **12 mm** tape width, for example 300 g for 9 mm width, is attached to one **end** of the tape specimen. The tape is held by the other end so that it is vertical and the adhesive side is brought into contact with the side of the rod (*see* Fig. 3A). The rod is rotated through 90° until the original point of contact *A* of the tape with the rod is at the top (*see* Fig. 3B). The tape is cut with a sharp tool at this point and the ma ss left suspended. The rod is then rotated one complete turn. The mass is removed and tape is cut at *D* by placing a sharp tool tangentially to the rod (*see* Fig. 3C) and tearing the tape against the tool. This gives an overlap of 1/4 turn (*see* Fig. 3D).

8.3.4 *Choice of Test Conditions*

8.3.4.1 *Adhesion to Backing* — The prepared specimen shall be conditioned in the vertical position for 7 days at 27 ± 2°C and 50 ± 5 percent RH.

8.3.4.2 *Curing Properties of Thermosetting Tapes* — The prepared specimens should be conditioned in the vertical position at the temperature and for the time prescribed by the manufacturer or in the relevant specification sheet.

8.3.4.3 *Resistance to Immersion in Liquids* — The prepared specimen, cured if necessary, shall be totally immersed in the vertical position in the prescribed liquid for 15 minutes at 27 ± 2°C.

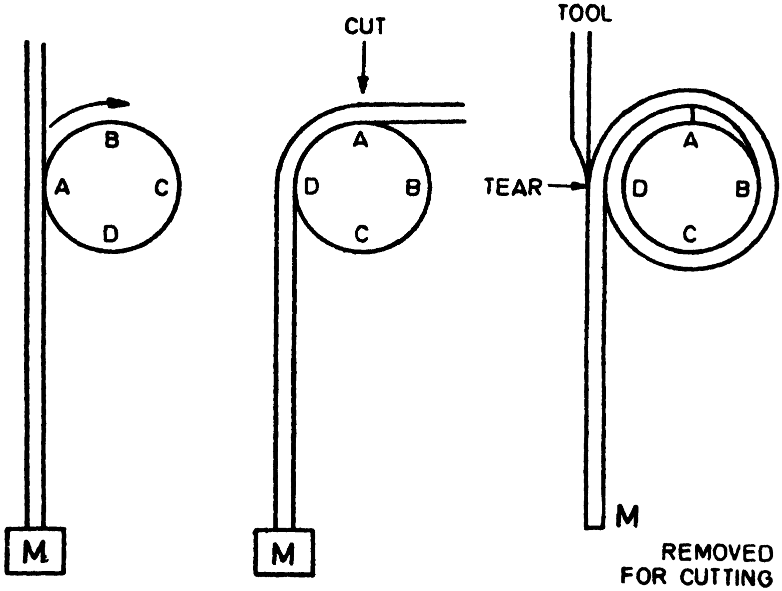
Thermosetting tapes shall be cured for the time and at the temperature prescribed and shall be allowed to cool to 27 ± 2°C before immersion in the liquid.

8.3.5 *Results* — The flag, for example the length of tape unwound (*see* Fig. 3D) shall be measured to the nearest 1 mm. Should uneven flagging occur, the greatest distance is measured.

The mean value of the three readings shall be recorded as the amount of flagging or end-lifting.

9. TENSILE STRENGTH AND ELONGATION AT BREAK

9.1 Apparatus — A tensile testing machine, power-driven, equipped with a continuous load indicating device calibrated so that one percent of the breaking load may be determined.

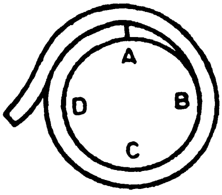


Not to scale

3A Placing Tape on the Rod

3B Cutting the Tape at *A*

3C Cutting the Tape at *D*



3D Overlap of ¼ Turn

FIG. 3 PREPARATION OF TEST SPECIMEN FOR FLAGGING TEST

9.2 Test Specimens — Five test specimens of sufficient length to give an initial test length of 200 mm are removed from the roll by pulling radially, at a rate of approximately 300 mm/s, at intervals of 300 mm.

If the width of the tape is 25 mm or less, the width of the specimen is the width of the tape.

If the width of the tape is greater than 25 mm, the specimen shall be cut out of the middle of the tape to a width of 25 mm. The specimens shall be cut with a sharp tool to avoid tearing at the edges.

9.3 Procedure — Insert the test specimen into the machine so that the load is applied evenly across the width of the tape. For tapes having an elongation at break up to 50 percent, the initial test length is 200 mm. For tapes having an elongation at break of more than 50 percent, the initial test length is 100 mm. The test specimen is elongated until it breaks:

a) either with a uniform rate of movement of the driven jaw of 300 ± 30 mm/min, or

b) with a rate of movement of the driven jaw of 50 mm/min for tapes with an elongation at break below 20 percent and with a rate of movement of the driven jaw of 100 mm/min for tapes with an elongation at break above 20 percent.

NOTE — An international agreement already exists for the use of 300 mm/min and consequently this possibility is included.

The maximum load is recorded. The elongation is determined by the increase in the distance between the jaws at the moment of break or, when specified in the material specification [*see* various sections of IS : 7809 (Part III)] by two marks on the tape at a distance of 50 mm.

Five valid determination are made, any test in which the test specimen breaks within 25 mm of either jaw being disregarded. It is necessary to take care to ensure that during the test the tape does not slip in the jaws of the testing machine.

9.4 Results — Report the width and the thickness of the test specimens in millimetres and the speed of loading.

To the extent required in the relevant material specification, the mean value and the maximum and minimum values of the five determinations are recorded for:

a) the tensile strength in newtons per 10 mm width for each millimetre thickness, and

b) the elongation at break in percent, determined as the increase in distance between the jaws or the marks, at the moment of break, expressed as a percentage of the original distance between the jaws or marks.

10. ADHESION

10.1 Apparatus

10.1.1 Five rectangular test plates of stainless steel of the following composition:

Carbon	0·16 percent, *Max*
Silicon	0·20 percent, *Min*

Manganese	2·00 percent, *Max*
Nickel	8-14 percent
Chromium	11-18 percent

A convenient size of plate is 200 × 50 mm; the thickness shall be at least 2 mm. The plate is marked at five equidistant intervals of 12·5 mm, 20 mm or 30 mm along one of the longer edges, the first mark being made at 50 mm from one of the ends. The test surface of the plate shall be polished to give an abrasive satin finish, the direction of gritting being parallel to the longer side of the plate. The surface roughness shall be determined according to IS : 3073-1967*.

Arithmetical mean deviation *R*a from the mean line of the profile shall be as follows:

$$0{\cdot}05/\mu m < R_a < 0{\cdot}40\ \mu m$$

10.1.2 A roller as described in **8.1.1** (a).

10.1.3 A tensile testing machine as described in **9.1.**

10.2 Test Specimens — Five strips 450 mm in length are removed from the roll by pulling radially, at a rate of approximately 300 mm/s, at intervals of 300 mm. The width of the strip is preferably 25 mm. If the width of the tape is greater than 25 mm, the specimen shall be cut out of the middle of the tape to a width of 25 mm. The specimen shall be cut with a sharp tool to avoid tearing at the edges.

NOTE 1 — It is important to protect the adhesive surface from dust and to avoid touching it with the fingers or any other foreign object.

NOTE 2 — Double sided tapes may be tested by removing the interleaving material and covering the adhesive surface not to be tested with soft tissue paper.

10.3 Procedure

10.3.1 *Cleaning* — The face of the plate is wiped with a fresh piece of cotton wool (surgical quality has been found satisfactory) saturated with pure toluene. The clean plate is allowed to dry and is then suspended above the liquid in a toluene vapour bath (a typical bath is shown in Fig. 4) and allowed to remain for 5 minutes after the vapour line has reached the top of the plate.

On removal from the vapour bath, it is suspended for approximately 30 minutes at 27 ± 2°C and 65 ± 2 percent RH.

10.3.2 *Preparation for the Adhesion to Steel Test* — The prepared plate is placed with the test surface upwards on the edge of a bench with end *B* (*see* Fig. 5) nearest the operator. The test specimen is applied with the adhesive surface downwards to the test surface of the plate.

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*Assessment of surface roughness.

NOTE — Glass cloth tapes which may break on 180° pull-back are to be backed-up with another thickness of the same tape. This modification shall be reported.

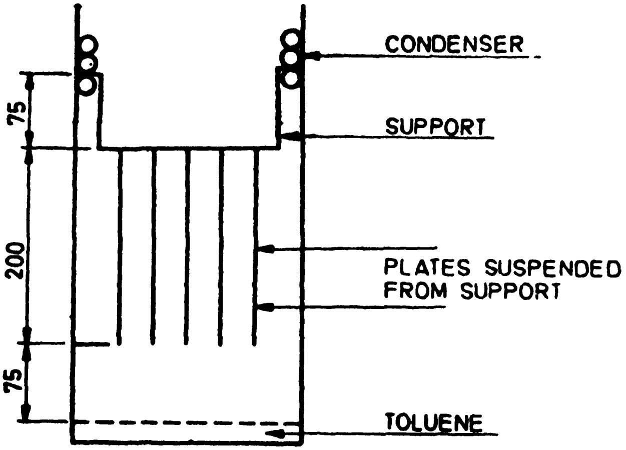

FIG. 4 TYPICAL TOLUENE BATH

Care is taken to ensure that the test specimen is unstretched and is applied centrally and parallel to the longer sides of the plate.

Take care that no air bubbles are trapped between the tape and the plate. Approximately 250 mm length of the test specimen overhangs end *B*. Place the roller centrally across the test specimen on one end of the plate and pass it, taking care not to apply any additional pressure, by hand at a constant speed four times over the test specimen on the plate, twice in each direction, so that each traverse of 200 mm occupies 10 to 12 seconds, ensuring that the roller travels in the exact line of the test specimen.

The excess tape overhanging end *A* is cut off and the adhesive specimen is removed as described in **10.3.4.**

The specimens shall be applied to the plates within 15 seconds of being taken from the roll of tape.

10.3.3 *Preparation for the Adhesion to Backing Test* — Carry out the test under the same conditions as described in **10.3.1,** but, before the actual test, apply to the steel plate a strip of the adhesive tape to be tested so that it overhangs a few centimetres. Bend over the free ends of this strip and stick them to the other side of the plate. Apply the test specimen to this strip and proceed as described in **10.3.4.**

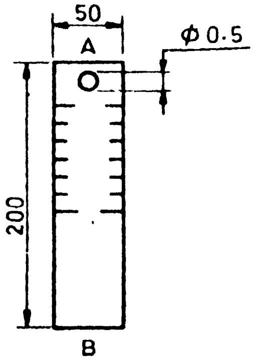

FIG. 5 STEEL TEST PLATE

10.3.4 *Stripping* — Allow the plate with the applied test specimen to remain undisturbed for 5 minutes at 27 ± 2°C and 65 ± 2 percent RH. Double back the free end of the test specimen and strip 25 mm to 50 mm from the plate of the backing at end *B*.

End *B* is placed in the traversing jaw of the testing machine and the free end of the test specimen is placed in the other jaw. Care should be taken to ensure that the free tape is parallel in both planes to the applied tape [this may be achieved by inserting backing in the lower jaw of the testing machine (*see* Fig. 6)]. The traverse jaw is set in motion at a rate of 300 ± 30 mm/min and the readings at five consecutive 12·5 mm, 20 mm or 30 mm interval marks are recorded. The test is performed at 27 ± 2°C and 65 ± 2 percent RH.

10.4 Results — Record the five readings on each of the five test specimens prepared in **10.3.2** and **10.3.3.** Arrange the five readings for each test specimen in ascending order and take the central value of each group. Arrange the five central values so obtained in ascending order and take the central value of these as the adhesion to steel or to backing as appropriate. Express the result in newtons per metre tape width.

11. SHEAR ADHESION TO BACKING AFTER LIQUID IMMERSION

11.1 Apparatus — It shall consist of the following:

a) A tensile testing machine, power-driven, equipped with a continuous load indicating device calibrated at intervals of 0·2 N or less. The

c) Temperature and humidity for conditioning before test, temperature and humidity during tests;

d) The break-down voltage at each puncture;

e) The central value of the five breakdown voltages for each specimen. Arrange the five central values so obtained in ascending order and take the central value of these as the breakdown voltage; and

f) Electric strength, in kilovolts per centimetre, calculated from the central value of the breakdown voltage according to (e) and average thickness according to (a).

13. ELECTRIC STRENGTH AFTER HUMID CONDITIONING

13.1 This test is carried out as described in **12** after storage of the specimens for 24 hours in the standard atmosphere of 27 ± 2°C and 93 ± 2 percent RH, unless otherwise specified.

14. ADHESION AT LOW TEMPERATURE

14.1 Test Specimens — Use the same type of specimen as described in **10.2,** but the number of specimens should be three. An additional three strips are needed to serve as backing.

14.2 Procedure — Before the specimens are applied to the plate as described in **10.3.3,** the three plates and the six strips shall be stored for 2 hours in a low temperature environment at the temperature prescribed in material specifications. The roller shall be at the same temperature. Storage of roller may need a longer time at the prescribed temperature due to its mass. The specimens shall be applied to the plate under the same low temperature conditions. Use the same type of application as described under **10.3.3.** Leave the prepared plates for 16 to 24 hours in the low temperature environment. Proceed with stripping according to **10.3.4** in the low temperature environment.

14.3 Results — Record the five readings for each of the three test specimens and treat them as in **10.4.**

15. ELONGATION AT LOW TEMPERATURE

15.1 Apparatus — It shall consist of the following:

a) Cold chamber maintained at the low temperature prescribed in material specification.

b) Frame suitable for supporting test specimens under the test load;

c) 4-kg weight;

d) Cotton gloves;
c) Steel rule graduated in millimetres; and
f) Stapler.

15.2 Test Specimens — Take three strips of tape each 400 mm long, 19 mm wide, and 12 strips 150 mm long of the same width. Tapes wider than 19 mm shall be cut to that width with a sharp tool to avoid tearing at the edges.

15.3 Preparation of Test Specimens — The 400 mm length of tape is laid on the bench, adhesive side uppermost. Place a 150 mm length of tape over each end of the 400 mm specimen with the adhesive surfaces in contact. Apply a thin layer of talcum powder to the 100 mm exposed length of adhesive tape and turn the specimen over. Place a 150 mm length of tape on to the two-ply sections at the ends of the specimen, with the adhesive surface in contact with the backing of the 400 mm length of tape. Two fine lines accurately marked 50 mm apart perpendicular to the edges are drawn centrally in the single-ply section. Fold the three-ply sections at each end of the specimen to form loops and staple loops closed using two staples for each loop. Alternatively, a pair of suitable clamps attached 100 mm apart may be used in place of stapled loops.

15.4 Conditioning — All test specimens and test equipment shall be conditioned for 2 hours at the temperature prescribed in materials specification.

15.5 Procedure — Mount the specimen on the support frame in the cold chamber using loop or clamp. At the end of the 2 hours conditioning period, attach test load using the other loop or clamp. After 3 hours under load at the prescribed temperature, measure to the nearest 1 mm the distance of inside edges of reference lines while still in the test chamber. The use of gloves when measuring specimen is necessary to avoid heating effect. Specimens that break during the test shall be discarded.

Calculate the percentage elongation:

$$\text{Percentage elongation} = \frac{\text{Final length} - \text{Initial length}}{\text{Initial length}} \times 100$$

15.6 Results — The percentage of elongation of all three specimens shall be reported.

16. OPTIONAL TESTS

16.0 These tests shall be conducted when required by the purchaser.

16.1 Water Vapour Permeability

16.1.1 *Apparatus* — A box made of non-corrodible metal, with external dimensions approximately 100 × 25 × 20 mm closed completely except that the top has a centrally placed rectangular opening 80 × 10 mm.

The inside of the box should be coated with a suitable lacquer and stoved. The empty box should weigh about 35 g.

16.1.2 *Procedure* — Clamp one end of a piece of the tape in a support so that it hangs vertically and clamp a weight equivalent to 25 g/mm width to the other end for 5 minutes*. Remove the tape from the clamps and press it down firmly over the opening in the box containing about 5 g of dry calcium chloride. Trim off any overlap of tape. Weigh the sealed box and place it in a desiccator containing water and then place the desiccator in an oven at 40°C. After 24 hours remove the box from the desiccator, allow to cool, wipe off any adherent moisture with a clean cloth, and reweigh. From the water vapour permeability per 24 hours per 800 mm^2 of tape thus determined, calculate the permeability as grams per square metre per 24 hours.

16.2 Unwind Characteristics (High Speed)

16.2.1 *Apparatus* — An unwind machine which allows the unwind force to be measured by means of an indicator and calibrated scale shall be required for this test method.

16.2.2 *Procedure* — The test procedure shall be as follows:

a) Thread the tape on the rewinding machine,
b) Unwind the whole roll at a speed of 45 ± 3 m/min,
c) Take three readings at random intervals throughout the unwinding of the roll, and
d) The average reading shall be reported as the unwind force in grams per centimetre width.

16.2.3 *Results* — The tape, without breaking, shall part cleanly from the underlayer, leaving the back of the underlayer free from transferred adhesive. The backing shall show no evidence of breaking, tearing or delamination.

16.3 Conductivity of Water Extracts

16.3.1 *Apparatus* — The apparatus for measurement of conductivity shall comprise a suitable conductivity cell, such as those shown in Fig. 7A and 7B† in conjunction with a bridge circuit supplied with current at a frequency of 500 Hz to 3 000 Hz.

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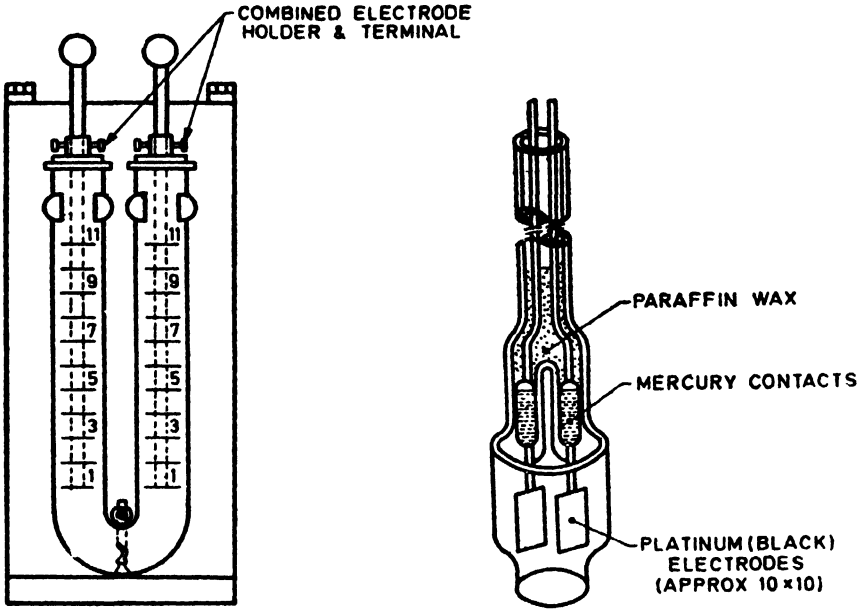
*Clamping for 5 minutes under 1-kg weight shall be done only for unplasticized PVC tapes.

†As an alternative to the conventional cell depicted in Fig. 7A an immersion electrode may conveniently be employed and inserted in a beaker or other suitable vessel containing the test solution. A suitable form of immersion electrode is shown in Fig. 7B.


COMBINED ELECTRODE HOLDER & TERMINAL
11
9
7
5
3
1
11
9
7
5
3
1
PARAFFIN WAX
MERCURY CONTACTS
PLATINUM (BLACK) ELECTRODES (APPROX 10×10)

7A Conventional Type of Cell

7B Immersion Electrode Type of Cell

All dimensions in millimetres.

FIG. 7 CELLS FOR DETERMINATION OF CONDUCTIVITY OF WATER EXTRACT

NOTE — For most purposes, where it is not convenient to test the water extract at 25 ± 1°C, it is sufficiently accurate to apply the following correction:

$$\text{Conductivity at } 25^\circ\text{C} = \frac{O}{1 \pm 0{\cdot}02\,t}$$

where O is the conductivity obtained when measurement is made at t degrees celsius different from 25°C, 0·02 t being added when measurement is made above 25°C and subtracted when made below 25°C.

16.3.2 *Preparation of Extract*

16.3.2.1 The distilled water used throughout this test shall have a conductivity not greater than 2 micromhos/cm. A blank test shall be carried out before each extraction and if the resultant conductivity exceeds 2 micromhos/cm the test shall be repeated with the same extraction vessel. If the second result also exceeds 2 micromhos/cm the vessel shall be discarded.

16.3.2.2 The extract shall be prepared by the following method. The tape shall be cut into strips about 20 × 3 mm and a mass of a tape in the ratio of one gram of the strips to 100 ml of distilled water shall be put into a 250-ml round-bottom borosilicate glass (high grade resistance glass) or quartz flask, fitted with a reflux condenser of either the same quality glass or quartz. The apparatus shall have interchangeable conical ground-glass joints. The water shall be boiled gently for 10 minutes, care being taken not to char the tape.

16.3.3 *Method of Measurement*

16.3.3.1 The cell constant *K*, if not known, shall first be determined by means of a solution of known conductivity, prepared by dissolving 0·746 g of dry potassium chloride in distilled water and diluting the solution to 1 000 ml at a temperature of 27°C. The cell shall be thoroughly rinsed out with the solution, then filled. The temperature shall be adjusted to 27 ± 1°C and maintained at that value for 15 minutes before, as well as during the measurement of resistance.

16.3.3.2 The test of the water extract shall be carried out as described in **16.3.3.1** above and as soon as practicable after its preparation.

If R = measured resistance of potassium chloride solution in megohms, and

R_1 = measured resistance of the water extract in megohms,

then

$$\textbf{The cell constant } K = R \times \left\{ 147{\cdot}4 + \begin{array}{l}\textbf{Conductivity of}\\ \textbf{the distilled water}\\ \textbf{in micromhos per}\\ \textbf{centimetre}\end{array} \right\}, \textbf{ and}$$

$$\begin{array}{l}\textbf{Conductivity of water}\\ \textbf{extract in micromhos per}\\ \textbf{centimetre}\end{array} = \frac{K}{R_1} - \left(\begin{array}{l}\textbf{Conductivity of the}\\ \textbf{blank in micromhos}\\ \textbf{per centimetre}\end{array} \right)$$

16.4 *p*H Values of Water Extracts

16.4.1 *Extraction* — A water extract of the tape shall be prepared as follows. The tape shall be cut into strips about 20 × 3 mm and a mass of tape in the ratio of one gram of the strips to 100 ml of distilled water having a *p*H value of not less than 6·6 and a conductivity not greater than 2 micromhos/cm shall be put into a 250-ml round-bottom borosilicate glass (high grade resistance glass) or quartz flask, fitted with a reflux condenser of either the same quality glass or quartz. The apparatus shall have interchangeable conical ground glass joints. The water shall be boiled for 10 minutes, care being taken not to char the tape. It shall then be cooled as rapidly as possible, using a carbon dioxide trap fitted to the condenser.

16.4.2 *pH Determination* — The *p*H value shall be determined by an electrometric method. It shall be determined as soon as possible after the preparation of the extract.

17. MIGRATION OF PLASTICIZER — Under consideration.

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